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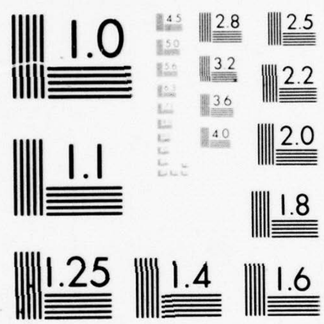

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INDIVIDUAL STUDY PROGRAM

CONTRACT WORK BREAKDOWN STRUCTURE (CWBS) FOR THE PATROL HYDROFOIL MISSILE (PHM) SHIP ACQUISITION PROGRAM: AN EVALUATION

STUDY PROJECT REPORT
PMC 77-2

William Harry Steele
GS-14 DNC

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DEFENSE SYSTEMS MANAGEMENT COLLEGE

STUDY TITLE:

CONTRACT WORK BREAKDOWN STRUCTURE (CWBS) FOR THE PATROL HYDROFOIL MISSILE (PHM) SHIP ACQUISITION PROGRAM: AN EVALUATION

STUDY PROJECT GOALS:

To evaluate the CWBS for the PHM production program against the Ship Work Breakdown Structure (SWBS) that would normally be required on the program and make recommendations about SWBS use on future programs.

STUDY REPORT ABSTRACT:

The purpose of the study project was to make an evaluation of the applicability of SWBS or the CWBS to the PHM production program. The study project is organized to give an overview of the PHM program, an explanation of the SWBS system, an explanation of the PHM CWBS, a comparison between SWBS and CWBS for the PHM program, and then a conclusion and recommendation section.

The results of the study showed that SWBS would not be a good system to use on the PHM production program because of the modular method of construction used vice the standard method of building ships. A recommendation is made that a careful examination of future shipbuilding programs be made to determine whether SWBS is the proper system to use or some other WBS system more compatible with modern shipbuilding techniques.

SUBJECT DESCRIPTORS:

SYSTEMS ENGINEERING MANAGEMENT, WORK BREAKDOWN STRUCTURE (10.05.01)

NAME, RANK, SERVICE	CLASS	DATE
William H. Steele, GS-14, DNC	PMC 77-2	November 1977

CONTRACT WORK BREAKDOWN STRUCTURE (CWBS) FOR
THE PATROL HYDROFOIL MISSILE (PHM) SHIP
ACQUISITION PROGRAM: AN EVALUATION

Individual Study Program

Study Project Report

Prepared as a Formal Report

Defense Systems Management College

Program Management Course

Class 77-2

by

William Harry Steele
GS-14 DNC

November 1977

Study Project Advisor
CDR. Herbert P. Woods, USN

This study project report represents the views, conclusions and recommendations of the author and does not necessarily reflect the official opinion of the Defense Systems Management College or the Department of Defense.

EXECUTIVE SUMMARY

This study report represents the results of the author's evaluation of the Contract Work Breakdown Structure (CWBS) for the Patrol Hydrofoil Missile (PHM) Ship Acquisition Program. It more specifically provides a comparison of the CWBS and the Ship Work Breakdown Structure (SWBS) and makes some conclusions about which is more applicable to the PHM production program.

The study was divided into five sections. The first section gives a detailed description of the PHM Ship Acquisition Program from its inception to the present time. In the second section, the SWBS is described and its application to ship conversion and acquisition programs discussed. The next section, the third, is a description of the CWBS for the PHM production program and how it applies to the construction methods used in the PHM construction. A comparison between the CWBS and SWBS is made in the fourth section with special emphasis being placed on their applicability to cost and schedule control on the PHM production program. The last section draws conclusions about the CWBS by listing advantages and disadvantages of CWBS versus SWBS. The conclusion drawn is that the CWBS is much more applicable to the PHM production program because of the method of construction for the PHM plus other considerations.

It is recommended that the SWBS be reviewed for applicability to modern ship acquisition construction methods and if it is determined that SWBS is not applicable to the construction methods of a program then a tailored CWBS should be used in its place.

TABLE OF CONTENTS

INTRODUCTION

In order to do an evaluation of the Contract Work Breakdown Structure (CWBS) for the Patrol Hydrofoil Missile (PHM) Ship Acquisition Program, it will be necessary to explain what a PHM ship is, what a CWBS is, what a Ship Work Breakdown Structure (SWBS) is, and make comparisons between the CWBS and SWBS to arrive at the evaluation.

The first section of the study will be an explanation of the PHM program from its inception and leading up to start of production. The PHM program is a NATO program and is the only joint NATO ship design program ever undertaken between the United States and any other NATO country.

For many years, the Naval Sea Systems Command has been trying to standarize the baseline for the language of ship acquisition. Their main attempt to accomplish this has been the SWBS and an instruction has been issued stating that the SWBS will be utilized in new ship acquisition programs. The second section of the study will deal with the SWBS including a fairly comprehensive description of the system.

The third section of the study will be a thorough explanation of the CWBS that has been approved for use in the PHM production program. The CWBS is unique to the construction methods being used in the PHM production program and the reasons for its uniqueness are clearly stated.

The next, or fourth section of the study is a comparison

between the CWBS and the SWBS. Primarily, the differences lie in cost and schedule control methods and in application of the CWBS or SWBS to the PHM construction methods.

The fifth section presents the conclusions arrived at during the study and makes certain recommendations about CWBS versus SWBS in future ship acquisition programs.

SECTION I

A description of the Patrol Hydrofoil Missile (PHM) Ship Aquisition Program

After a year's study of the growing Soviet surface ship fleet, including fast patrol craft, the NATO Naval Armaments Group (NNAG) determined that a hydrofoil such as the PHM was the only state-of-the-art ship having the requisite high speed and superior sea-keeping characteristics to meet the NATO requirement for a new generation of fast patrol boats.

A contract was issued to The Boeing Company in November 1971 for the PHM Contract Design Phase and procurement of long lead time material. Defense System Acquisition Review Council (DSARC) II for full scale development was held on September 26, 1972 with the decision from the meeting approving construction of two lead ships in fiscal year (FY) 1973. It further authorized the Secretary of the Navy to sign a NATO PHM Memorandum of Understanding (MOU) between the United States (U.S.), the Federal Republic of Germany (FRG) and the Government of Italy (GOI). In addition, the DSARC II approved six additional follow-on PHMs and planning for an out year production program. This is the only joint NATO ship design program even conducted between another NATO country and the U.S.

The FRG and GOI expressed interest in the program in early

1972 by signing a letter of intent to participate in the program. This was followed by the FRG and GOI signing the NATO PHM MOU in November 1972 indicating their participation in the PHM contract design and detail design efforts.

In February 1973, a cost plus fixed fee contract was signed with The Boeing Company for the detail design of the PHM, construction of two U.S. PHMs, and a production data package that would permit the FRG and GOI to either build their own PHMs or have The Boeing Company build them.

The GOI decided in 1974 to not participate in the joint production program with the U.S. and the FRG. The FRG did have a detail design prepared for an FRG variant ship and did participate with the U.S. in a producibility contract that was awarded on July 29, 1975. The producibility contract effort was to provide a ship which is less costly and more easily constructed than the prototype PHM ship.

The design of the ship started with the circular of requirements specification that was issued December 17, 1971 which led to a NATO Standard Ship System Requirements that evolved into the Ship System Description. The Ship System Requirements and the Ship System Description were then combined, modified, and expanded into the formal Ship System Specifications which were approved for the production program on June 11, 1976.

The PEGASUS (PHM-1) was the first prototype PHM ship

and was launched on November 9, 1974. The first hullborne tests on PHM-1 were conducted on February 14, 1975 and the first foilborne tests on February 25, 1975. The Technical Evaluation of PHM-1 was completed on January 11, 1976 with the Operational Evaluation completing on June 9, 1976. The ship then underwent an upkeep period to correct any deficiencies discovered during Technical Evaluation and Operational Evaluation and was commissioned and delivered to the fleet in July 1977.

The request for proposal (RFP) for the production program was issued to The Boeing Company on June 18, 1976. A Pre-Production Readiness Design Review was held on the production program on August 25, 1976. The Boeing Company proposal in response to the RFP was received by the Navy on October 15, 1976 and a Pre-Award Survey was conducted on The Boeing Company from November 1 to November 23, 1976 at which time a modified Production Readiness Review was also conducted.

The DSARC III for production was held on December 9, 1976 with a verbal authority to proceed being provided to the Navy on December 23, 1976 and a formal written approval provided by Secretary of Defense memorandum on January 10, 1977. After some delays, a production contract for five PHMs was awarded to The Boeing Company on October 20, 1977.

SECTION II

A Discussion of the Ship Work Breakdown Structure (SWBS)

As the Navy got more deeply involved in the Program Management business in ship construction and conversion programs, they discovered that they needed a better method of communication between the Program Manager and all other participants in those programs.

On March 1, 1973, the Naval Sea Systems Command published a document called a Ship Work Breakdown Structure (SWBS). The purpose of this document was to provide a single language to span the total life cycle of a ship from its early concept phases, through production, and to its disposition as it was retired from active duty. The single language was to facilitate communications and discussions about cost, weight, specifications, system function and effectiveness, design, production and maintenance about the ship construction or conversion program.

The SWBS was originated to replace two previous systems that were being utilized for communication purposes. The two previous systems were the Bureau of Ships Consolidated Index of Drawings, Materials and Services Related to Construction and Conversion (BSCI) and the Ship Design and Material, Group 9000 Series, of the Navy Standard Subject Identification Codes (SSIC). The BSCI was used for cost and weight estimat-

ing and reporting, progress reporting for new construction and conversion ships, and drawing numbering. The SSIC was used for correspondence and filing, technical document numbering, and numbering sections of ship specifications. The SSIC and its predecessor had been in existence for almost 50 years and it was very appropriate to update the system after that many years of constant use.

The SWBS document states:

> If you are in any way connected with ship design or construction, this document will affect your work. It will be your guide for categorizing weight classification, cost estimating, progress reporting, drawing numbers, Ship Specification section numbers, writing of (and charging of services to) work requests or similar documents, as well as indexing materials and components. This document provides a classification system whereby all phases of a ship acquisition or conversion project are identified, correlated, and categorized under a single functional index that addresses requirements, material, services, and components (6:iii).[1]

From this description, it is fairly obvious that the SWBS is capable of replacing the BSCI and the SSIC for those functions that were previously covered under those two systems.

The SWBS was developed from Appendix E of MIL-STD 881, Work Breakdown Structures (WBS). It is based on the functional concept and all the classification groups have been defined by basic function. Basic functions are such as machinery,

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[1]The first number is the source listed in the bibliography. The second number is the page in the reference.

hull, armament, outfitting, etc., and these basic functions are categorized using a system of three numeric digits for each function.

The functions are divided into ten major groups, the first one being for government control and the last two primarily for cost estimating and progress reporting respectively. The ten major groups are:

000	General Guidance and Administration
100	Hull Structure
200	Propulsion Plant
300	Electric Plant
400	Command and Surveillance
500	Auxiliary Systems
600	Outfit and Furnishings
700	Armament
800	Integration/Engineering
900	Ship Assembly and Support Services

Each of the major groups are further divided into subgroups and elements. For example:

Group	200 - Propulsion Plant, General
Element	201 - General Arrangement - Propulsion Drawings
Subgroup	210 - Energy Generating System (Nuclear)
Element	211 - (Reserved)
Element	212 - Nuclear Steam Generator

The SWBS structure was established to provide the following interpretation (as stated in the SWBS document):

- Groups 100 through 700 equal hardware cost and weight Condition A (Light ship without margin)

- Groups 100 through 700 plus 800 and 900 equal ship construction cost

- Groups 000 plus 100 through 700 plus 800 and 900 equal total ship cost for Condition A (6:3)

Individual ship components are classified first by group, then by subgroup, and then by element (see figures 1 and 2 taken from the SWBS document)(6:4-5).

Since the SWBS was established as a single system to apply to a wide variety of special purpose indicies, it has been done as a compromise between all the systems in order to be effective as a single system. The SWBS document gives specific directions on how to utilize the document to satisfy all the different requirements for its use.

The SWBS system would work for a ship construction where the ship was hand crafted from the keel laying to production completion in the accepted shipbuilding methods. The SWBS has been the basis of Contract Work Breakdown Structures (CWBS) for large surface ship construction programs but the 000 Group would not be included unless the contractor was doing some work normally conducted by the government.

The Naval Sea Systems Command issued an instruction on August 26, 1974 implementing the SWBS for all new construction and conversion programs. The SWBS document was updated and reissued on August 1, 1977 by the Naval Ship Engineering Center who prepared and published it for the Naval Sea Systems Command.

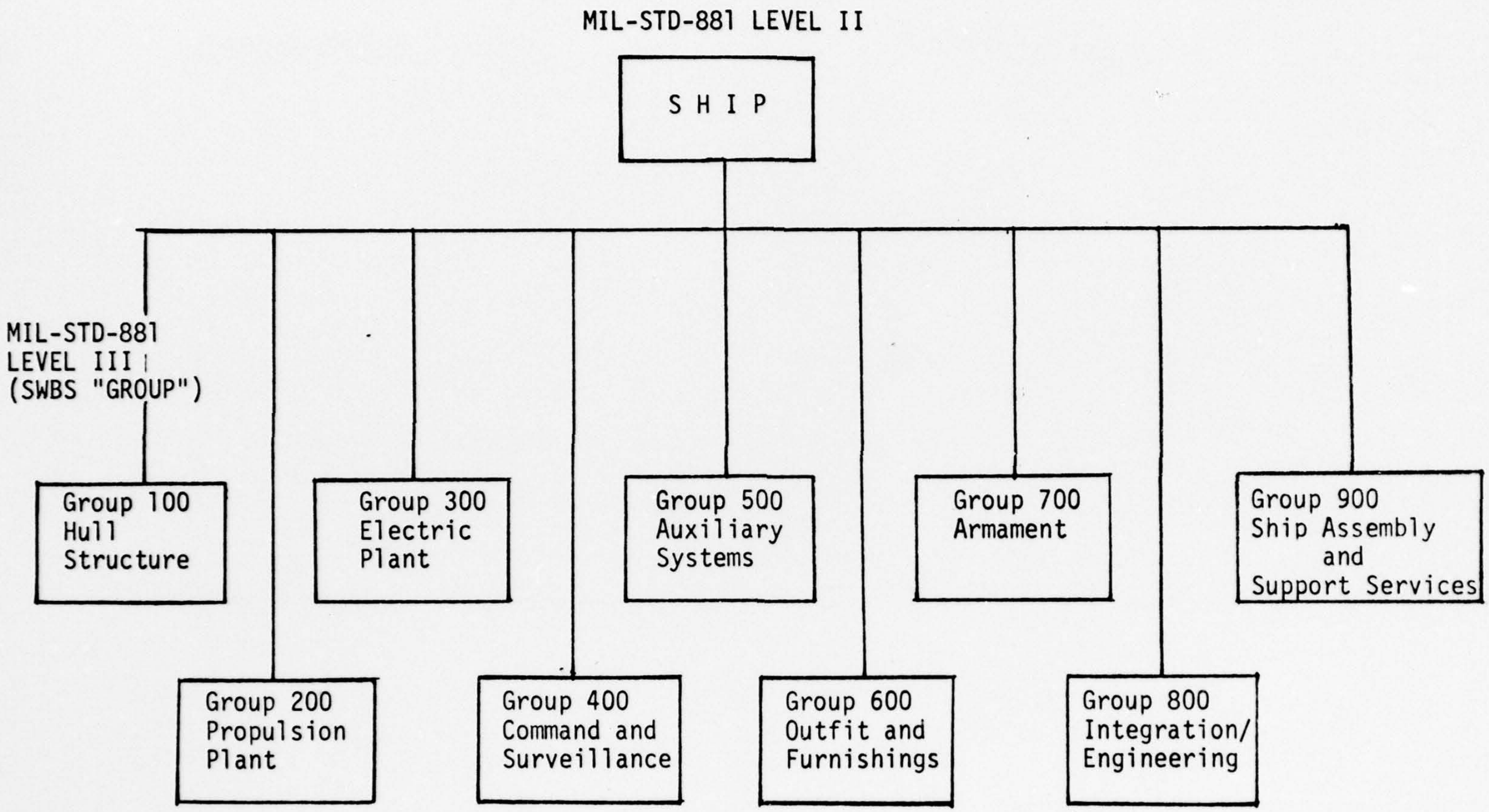
MIL-STD-881 LEVEL II
S H I P
MIL-STD-881
LEVEL III
(SWBS "GROUP")
Group 100
Hull
Structure
Group 200
Propulsion
Plant
Group 300
Electric
Plant
Group 400
Command and
Surveillance
Group 500
Auxiliary
Systems
Group 600
Outfit and
Furnishings
Group 700
Armament
Group 800
Integration/
Engineering
Group 900
Ship Assembly
and
Support Services

FIGURE 1

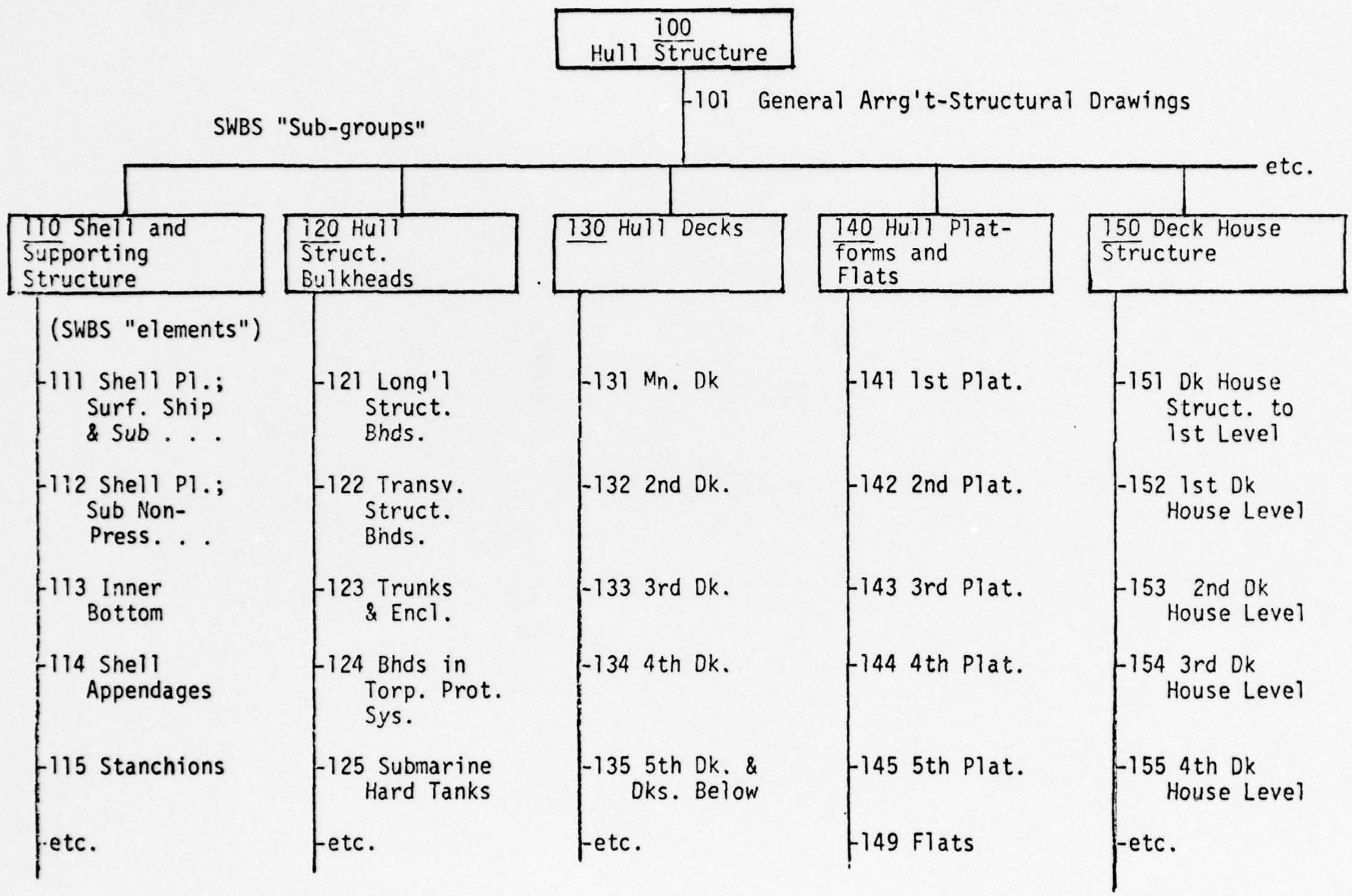
100
Hull Structure
101 General Arrg't-Structural Drawings
SWBS "Sub-groups"
etc.
110 Shell and Supporting Structure
120 Hull Struct. Bulkheads
130 Hull Decks
140 Hull Platforms and Flats
150 Deck House Structure
(SWBS "elements")
111 Shell Pl.; Surf. Ship & Sub . . .
112 Shell Pl.; Sub Non-Press. . .
113 Inner Bottom
114 Shell Appendages
115 Stanchions
etc.
121 Long'l Struct. Bhds.
122 Transv. Struct. Bhds.
123 Trunks & Encl.
124 Bhds in Torp. Prot. Sys.
125 Submarine Hard Tanks
etc.
131 Mn. Dk
132 2nd Dk.
133 3rd Dk.
134 4th Dk.
135 5th Dk. & Dks. Below
etc.
141 1st Plat.
142 2nd Plat.
143 3rd Plat.
144 4th Plat.
145 5th Plat.
149 Flats
151 Dk House Struct. to 1st Level
152 1st Dk House Level
153 2nd Dk House Level
154 3rd Dk House Level
155 4th Dk House Level
etc.

FIGURE 2

SECTION III

A discussion of the PHM production Contract Work Breakdown Structure (CWBS)

In order to understand the evolution of the PHM production CWBS, it is necessary to provide some background on the reasons for a deviation from the SWBS normally utilized in a new ship construction program.

The CWBS that was utilized for the prototype PHM followed the MIL-STD-881 format quite closely but it was discovered that it was difficult to track cost and schedule progress against this CWBS. The prototype CWBS also followed the SWBS requirements quite closely since the SWBS is developed from the MIL-STD-881. The major deviation in the CWBS was the numbering system. The main problem in tracking cost and schedule progress was that the PHM ships were not being constructed with normal shipbuilding techniques and therefore the SWBS was not directly applicable to the construction.

Considerable discussion was carried on between the PHM Project Office and The Boeing Company as preparations for issuance of the request for proposal (RFP) were being conducted. The Boeing Company had stated that they planned to construct the production PHMs in a modular method instead of hand crafting them from the keel up as was being done on other shipbuilding at this time. They requested that a different CWBS be requested in the RFP than that which was required

by MIL-STD-881 and the Naval Sea Systems Command instruction on use of the SWBS for all new ship construction. This request was forwarded by The Boeing Company to the Assistant Secretary of the Navy (Installations and Logistics) (ASN(I&L)) who directed the Navy to work with The Boeing Company to derive the best CWBS that would be applicable to the PHM Program. After considerable effort between the PHM Project Office and The Boeing Company, a CWBS outline was prepared that was approved by ASN(I&L) who granted a waiver for its use on the PHM program. The production CWBS for the PHM program was then prepared by The Boeing Company based on the outline which had been approved by the ASN(I&L) and the requirements of the RFP that had been issued for the PHM production program. The CWBS was an integral part of the proposal that was submitted in response to the RFP.

The CWBS is correlated in the ship construction area with the modules which will be fabricated or outfitted at each of the tool positions. However, the normal SWBS breakdown of functions is maintained in the engineering area of the CWBS while other areas are similar to the SWBS but not a copy of it.

The major groups of the CWBS are:

1.000	Ship Construction
2.000	Engineering
3.000	Integrated Logistic Support
4.000	Program Management and Services
5.000	Data
6.000	Industrial Facilities

7.000	Government Furnished Property Repair
8.000	Undistributed Budget
9.000	Overhead
10.000	General and Administrative
11.000	Fringe
12.000	Reserve

There are subgroups within each of the groups, except 7.000-11.000 which are single line groups, and the subgroups are further divided into elements. For example:

Group	1.000 - Ship Construction
Subgroup	1.100 - Hull and House
Element	1.1A00 - Forward Lower Hull Assembly Tool 1
Element	1.1B00 - Platform Deck Join Tool 2
Element	1.1R00 - Lot time/Support/Material

Some of the elements have subelements that go down to the fifth level of the CWBS where that type of clarity is required. The CWBS described above is that which is provided by The Boeing Company to the PHM Project Office but The Boeing Company has further levels of the CWBS as low as eighth and ninth levels for company use.

Some of the groups would appear to not fit into a normal CWBS except for the fact that the CWBS is also utilized in the Contract Control Matrix. The Contract Control Matrix is a matrix which is product oriented running down the vertical axis and is functionally oriented going across the horizontal axis. The Contract Control Matrix identifies the cost account level (which Boeing calls a financial imput unit)

and the financial reporting level for customer reporting. The same modules and tool positions identified on the CWBS are also Gantt charted on the Master Program Schedule. The important item to note here is that the same CWBS is used for financial accounting and physical progressing which means that the whole system is tied together with the same baseline.

There is another document associated with the CWBS that is termed the Weighted Work Breakdown Structure which has as its primary function that of assigning the proportion of program cost allocated to each CWBS element and is separated into four categories titled Non-Recurring Labor, Non-Recurring Non-Labor, Recurring Labor, and Recurring Non-Labor. Those four categories are then further sub-divided and costs allocated to the CWBS elements so that all 100% of the contract costs are allocated to the four categories. The Weighted WBS also is directly associated with the Cost Segregation Plan which was originally prepared because of a requirement to segregate all costs so that U.S. and FRG costs could be separately identified and collected from the government responsible for the costs. The baseline used for the Weighted WBS and the Cost Segregation Plan was again the CWBS.

The Cost/Schedule Control System (C/SCS) Plan for the PHM production program is in accordance with DOD Directive 7000.2 requiring that all major acquisition programs invoke the C/SCS criteria. Again, the basis for the C/SCS Plan for cost

account allocation and required reporting is based on the CWBS.

It is fairly obvious that the PHM production program will utilize a single baseline for cost and schedule allocation and for cost and schedule reporting and that baseline is the CWBS.

SECTION IV

A comparison of the SWBS and the PHM production CWBS

The Naval Sea Systems Command Instruction 4790.1 of August 26, 1974 states:

> The SWBS provides a classification system whereby all phases of a ship acquisition or conversion project are identified, correlated, and categorized under a single functional index that addresses requirements, material, services and components. (5.1)

There is no dispute that a single functional index is required, during a ship acquisition program, to satisfy all the requirements of the instruction. The question that arises is whether the SWBS is the best and only system to use or whether another system would be more satisfactory.

Most ship construction is done by laying the keel and building upon that keel until a total ship is erected much like building a house on a foundation. Although some ships are constructed using a modular approach, the modules are usually very large and the construction certainly doesn't appear to be an assembly line approach. This type of construction is somewhat suited to the SWBS format and the SWBS can be used as a model when preparing the CWBS. However, when the ships are not constructed in this manner, there may be another WBS that would work better than the SWBS.

The CWBS which has been negotiated between The Boeing Company and the PHM Project Office is believed to be a better WBS for the PHM production program than SWBS. It satisfies the requirements of the Naval Sea Systems Command instruction since it does use a single functional index that addresses all the requirements of the instruction. Some might dispute the use of the word "functional" in "single functional index" and it would have to be agreed that "functional" doesn't apply to the CWBS but it is a single index which is the prime requirement. It also satisfies the requirement that the WBS reflect the manner in which the weapon system is actually built and the CWBS does that.

It would be extremely difficult to get accurate cost and schedule progressing on the PHM production program when using the SWBS. The Boeing Company accounting system and its scheduling system are not compatible with the SWBS but are compatible with the CWBS. When using SWBS, most schedule progressing is done by physically estimating the percentage of completion of the system. The system being evaluated may run from one end of the ship to the other so it would be very difficult to get an exact measurement of the completion of the system. With the CWBS, the work will be scheduled by modules in a tool position with discrete schedule progressing available when the module leaves one tool position and moves to another. The budget is distributed to the cost

account level (or tool position) and then further to the operations within each cost account (or tool position). The costs are collected for each operation and then for each cost account which is at the same level that modules and tool positions in the schedule are allocated to. This will permit far more discrete cost monitoring than has been achieved on other shipbuilding programs using SWBS as the baseline system.

SECTION V

Conclusions and recommendations

It would be a good idea at this point to make a comparison of the advantages and disadvantages of the CWBS versus the SWBS. The advantages of CWBS over SWBS are:

- CWBS defines the way the ship will be constructed while SWBS does not.

- Discrete identification of operations within modules and tool positions provides discrete cost and schedule control which is not available with SWBS on this program.

- Costs will be allocated and collected in the same manner that progress is reported and the ship is constructed which would not be the case with SWBS on this program.

- Learning skill improvement will be better because of repitition on small packages of work which wouldn't be true with SWBS.

- There is early identification of problems with CWBS, while this has been one of the complaints with SWBS that it does not provide early enough detection of problems.

The disadvantages of CWBS versus SWBS are:

- Weight reporting for the ship has normally been done by system to be compatible with the Naval Sea Systems Command history file and this cannot be done with CWBS.

- Cost estimates are normally reported in SWBS format to

update the Naval Sea Systems Command parametric cost estimating file and this cannot be done with CWBS.

In order to satisfy the requirements and overcome the two disadvantages, The Boeing Company has been required to supply a one-time cross correlation of PHM program cost estimates in the SWBS format from the CWBS format. This will satisfy the requirement to provide cost estimates to update the parametric cost estimating data file. The only solution to the weight reporting requirement is to provide the weight reporting in SWBS format and this will be done.

From the preceding listing of advantages and disadvantages, it indicates that the SWBS system may not be the only way to proceed but that a CWBS prepared and based on the method the ship will be constructed would be a more practical approach. Time will tell whether the CWBS will function on the PHM production program as well as it appears that it will. However, it does seem that a long look should be taken at the SWBS system and instructions requiring its use toward a change to a more tailored system applicable to more modern ship construction methods.

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